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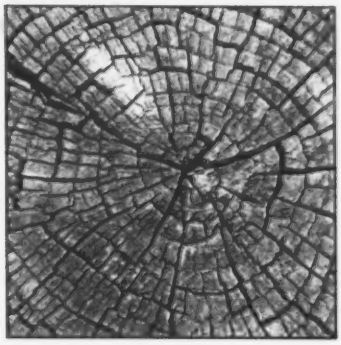

by Michael Tjepkema, Russell Wilkins, Jennifer Pennock and Neil Goedhuis

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Abstract

Background
Compared with other Canadians, First Nations peoples experience a disproportionate burden of illness and disease. Potential years of life lost (PYLL) before age 75 highlights the impact of youthful or early deaths.

Data and methods
The 1991 to 2001 Canadian census mortality follow-up study tracked a 15% sample of adults aged 25 or older over more than a decade. This study examined mortality among people aged 25 to 74—55,600 Status Indians (39,200 on reserve and 16,500 off reserve) and 2,475,700 non-Aboriginal adults—all of whom were enumerated by the 1991 census long-form questionnaire. Age-standardized PYLL rates were calculated, based on the number of person-years at risk before age 75.

Results
Status Indian adults had 2.5 times the risk of dying before age 75, compared with non-Aboriginal adults. Results did not differ greatly by residence on or off reserve. Relative and absolute inequalities were greatest for unintentional and intentional injuries. Socio-economic factors such as income, education, housing and employment explained a substantial share of the disparities in premature death.

Interpretation
Status Indian adults had higher rates of premature mortality. Socio-economic factors played an important role in those disparities. Injuries were important contributors to both relative and absolute inequalities.

Keywords
Aboriginal, cause of death, death rate, First Nations, indigenous, life expectancy, longevity, mortality

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Compared with other Canadians, First Nations peoples experience a disproportionate burden of illness and disease,[1-3] which is reflected in shorter life expectancy. For Status Indians, life expectancy at birth is 8 years less for men and 7 years less for women.[4] Life expectancy, however, tends to be dominated by deaths at older ages. A complementary way of examining mortality is to focus on premature mortality, specifically, potential years of life lost (PYLL) before age 75. PYLL sums the additional years people would have lived if they had had a full lifespan.[5]

The rate of premature death, and by extension, PYLL, is higher for Status Indians than for other Canadians.[6-9] Possible reasons include differences in broad social determinants of health, such as income, education, and housing quality[10] that are experienced over a lifetime.[11] Despite their importance,[12,13] these factors have not usually been included in analyses of mortality differences between Aboriginal and non-Aboriginal populations.[13] However, with the 1991 to 2001 Canadian census mortality follow-up study, it is possible to examine the effect of socio-economic variables on the disparity in premature death between Status Indian and non-Aboriginal adults.

This article presents estimates of PYLL at ages 25 to 74 for Status Indians living on or off reserve, identifies the causes of death for which disparities between Status Indians and non-Aboriginal Canadians were greatest, and examines the effects of socio-economic factors on those differences.

Methods

Data sources

The 1991 to 2001 Canadian census mortality follow-up study is a probabilistically linked cohort consisting of a 15% sample (n = 2,735,152) of the non-institutional population aged 25

or older, all of whom were enumerated via the 1991 census long-form questionnaire.[14] This cohort was tracked for mortality from June 4, 1991 through December 31, 2001.

Because names were not captured on the census database, but were needed for linkage to the mortality database, creation of the cohort required two probabilistic linkages. First, eligible census respondents were linked to a nominal list (name) file (abstracted from 1990 and 1991 tax-filer data and then encrypted) using common variables such as date of birth, postal code, and spousal date of birth (if applicable); 80% of eligible respondents were successfully matched. Second, the census plus encrypted names were matched to the Canadian Mortality Database.[15] Based on 1991 deaths, which could be identified independently in the Canadian Mortality Database and/or the name file, ascertainment of deaths among the cohort overall from 1991 to 2001 was estimated at 97%, and 95% to 96% among cohort members reporting any Aboriginal ancestry, Registered Indian status, or membership in an Indian Band or First Nation.

Eligibility

People enumerated by the 1991 census long-form questionnaire who had reached age 25 by census day were eligible to be part of the cohort. The long form, which was usually given to 1 in 5 households, was administered to all residents of Indian reserves, many remote and northern communities, and non-institutional collective dwellings. However, 78 Indian reserves, representing about 38,000 people, were either not enumerated or incompletely enumerated,[16] and thus, were not part of the cohort. As well, data quality reports found that the 1991 census missed 3.4% of Canadian residents; these individuals were more likely to be young, mobile, low income, of Aboriginal ancestry,[17] or homeless.

Because it was necessary to obtain encrypted names from taxation data, only tax-filers could be followed for mortality. Under Section 87 of the *Indian Act*, Status Indians are entitled to an exemption for income earned or considered to be earned on a reserve.[18]

Owing to the exclusion of institutional residents and non-tax-filers, life expectancy of the cohort at age 25 was 1 year longer for men and 2 years longer for women, compared with 1995 to 1997 life tables for all Canada. This bias would apply equally to Aboriginal and non-Aboriginal cohort members and should not appreciably affect relative differences between the two groups.

Analytical techniques

The cohort was divided into ten one-year follow-up periods (June 4, 1991 to June 3, 1992; June 4, 1992 to June 3, 1993; and so on) and one seven-month period (June 4, 2001 to December 31, 2001). Age was transformed from age at baseline (June 4, 1991) to age at the beginning of each year of follow-up. Deaths and person-years at risk were calculated separately for each follow-up period, and then pooled by five-year age group (determined at the beginning of each year of follow-up).

Deaths before age 75 were considered premature. The number of potential years of life lost (PYLL) was calculated by multiplying the number of deaths in each age group by the mean number of potential years of life lost for the same age group. For example, the death of someone aged 25 to 29 would contribute 47.5 potential years of life lost before age 75.

To calculate rates of PYLL, the number of person-years at risk (up to age 75) was determined for each five-year age group, and the rates were age-standardized to the Aboriginal population. The Aboriginal age distribution was based on those in the cohort who indicated an Aboriginal ancestry, registration under the *Indian Act of Canada*, or membership in an Indian Band or First Nation. Confidence intervals for the age-standardized rates were produced from variances derived using the Spiegelman method.[19]

Premature mortality (Cox models)

For each cohort member, person-days of follow-up were calculated from baseline (June 4, 1991) to the date of death, emigration (known only for 1991), end of study (December 31, 2001), or until the person reached age 75. Because exact date of birth was not available on the analysis file, age in completed years (as of June 4 of each follow-up year) was used to derive age at death and person-years of follow-up.

Cox proportional mortality hazard ratios were used to estimate the effect of socio-economic factors on the disparity in premature mortality between Status Indians and non-Aboriginal adults. All models were sex-specific and were run separately for Status Indians on and off reserve. The base model (Model 1) controlled only for age. Models 2 to 7 controlled for age and one other socio-economic factor. The full model (Model 8) controlled for age and all socio-economic factors simultaneously. Differences in excess mortality (1 minus the hazard ratio) comparing the full model to the base model were interpreted as estimates of the effect of the socio-economic variables on the disparities. The variables controlled for were age, marital status (married/common-law, not married), single parent (yes, no), educational attainment (less than secondary graduation, secondary graduation, postsecondary diploma, university degree), income adequacy quintile, labour force status (in, not in), crowding (more than one person per room; yes, no); home ownership (yes, no), dwelling in need of major repairs (yes, no), and urban population size (1 million or more; 500,000 to 999,999; 100,000 to 499,999; 10,000 to 99,999; less than 10,000).

Cause of death

The underlying cause of death of those who died during the study period had been previously coded to the World Health Organization's *International Classification of Diseases, Ninth Revision* (ICD-9)[20] for deaths occurring from 1991 through 1999, and to the *Tenth Revision* (ICD-10)[21] for deaths occurring in 2000 or 2001. Deaths were also grouped by the Global Burden of

Disease categories, which underscore human development rather than the body system,[22] and by risk factors, namely, smoking-related,[23] alcohol-related[23] and drug-related diseases[24] or premature deaths that are potentially amenable to medical intervention.[23]

Definitions

Registered Indian status was determined by a direct census question: "Is this person a *Registered Indian* as defined by the Indian Act of Canada?" (yes, no). A respondent answering "yes" was considered a Status Indian.

Place of residence was determined for June 4, 1991; subsequent mobility was not tracked. Indian reserves were defined to include the following types of census subdivisions: Indian government district; Indian reserve; Indian settlement; Terres réservées; Village Cri; Village Naskapi; Village nordique. All other areas were classified as off reserve.

Results

Baseline characteristics

The demographic and socio-economic characteristics of Status Indian cohort members differed from those of non-Aboriginal members and also varied by on- or off-reserve residence (Appendix Table A). Compared with non-Aboriginal adults, Status Indians were younger and less likely to be legally married. Status Indians, particularly those living on reserves, were less likely to have completed secondary school, to be employed, and to be homeowners, and were more likely to be in the two lowest income adequacy quintiles and to live in crowded conditions and in dwellings needing major repairs.

Status Indians tended to die earlier than did non-Aboriginal people. Of all deaths of Status Indian cohort members that occurred at ages 25 to 74, 28% were at ages 65 to 74, compared with more than 50% of the non-Aboriginal deaths (Appendix Table B).

Table 1
Age-standardized rate ratios (RR) for potential years of life lost at ages 25 to 74 for Status Indian men living on and off reserve, compared with non-Aboriginal men, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RR	from	to	RR	from	to	RR	from	to
All causes	2.45	2.26	2.66	2.67	2.43	2.93	1.88	1.61	2.21
Communicable, maternal, perinatal and nutritional conditions	1.42	1.01	2.01	1.49	0.99	2.26	1.25	0.72	2.17
Infectious and parasitic diseases	0.96	0.59	1.56	0.96	0.52	1.78	0.97	0.50	1.86
HIV/AIDS	0.72	0.36	1.43	0.74	0.31	1.77	0.67	0.28	1.65
Respiratory infections	5.86	3.69	9.32	6.58	3.98	10.88	4.01	1.45	11.05
Non-communicable diseases	1.76	1.60	1.93	1.85	1.67	2.06	1.50	1.22	1.85
Malignant neoplasms	0.97	0.81	1.16	0.93	0.76	1.14	1.06	0.73	1.54
Stomach cancer	2.01	1.14	3.54	1.86	0.94	3.67	2.38	0.87	6.52
Colon and rectal cancers	1.41	0.67	2.98	0.71	0.40	1.25	3.22	1.04	9.98
Pancreas cancer	0.83	0.46	1.48	0.54	0.22	1.33	1.67	0.81	3.46
Trachea, bronchus and lung cancers	0.86	0.68	1.10	0.75	0.56	1.00	1.16	0.76	1.78
Prostate cancer	1.11	0.67	1.84	0.92	0.46	1.87	1.71	0.88	3.31
Lymphomas and multiple myeloma	0.83	0.51	1.35	0.88	0.50	1.56	0.71	0.29	1.71
Diabetes mellitus	4.98	3.75	6.63	5.70	4.17	7.79	2.95	1.56	5.57
Neuropsychiatric conditions	4.21	2.98	5.95	4.76	3.20	7.06	2.78	1.52	5.07
Alcohol use disorders	13.08	9.04	18.93	15.29	10.24	22.84	7.25	3.17	16.58
Cardiovascular diseases	1.71	1.48	1.98	1.74	1.48	2.04	1.63	1.17	2.26
Ischemic heart disease	1.66	1.43	1.92	1.73	1.46	2.04	1.45	1.05	1.99
Cerebrovascular disease	1.88	1.05	3.37	1.45	0.93	2.27	3.00	0.92	9.77
Respiratory diseases	2.39	1.58	3.60	2.94	1.87	4.60	0.91	0.43	1.91
Chronic obstructive pulmonary disease	1.52	0.96	2.39	1.75	1.06	2.89	0.83	0.29	2.43
Digestive diseases	4.00	3.01	5.33	4.80	3.49	6.60	1.87	1.12	3.13
Cirrhosis of the liver	4.57	3.06	6.80	5.47	3.50	8.55	2.20	1.14	4.23
Genitourinary diseases	6.28	3.07	12.85	x	x	x	x	x	x
Injuries	3.72	3.23	4.27	4.09	3.49	4.78	2.74	2.08	3.61
Unintentional injuries	4.57	3.85	5.41	4.91	4.06	5.93	3.67	2.62	5.13
Road traffic accidents	4.09	3.11	5.37	4.54	3.37	6.13	2.88	1.62	5.15
Poisonings	3.12	2.01	4.83	2.79	1.67	4.67	3.94	1.89	8.20
Falls	2.56	1.41	4.63	2.85	1.57	5.17	1.76	0.34	9.16
Fires	6.53	2.99	14.30	7.68	3.21	18.40	3.52	1.15	10.80
Drownings	10.45	6.00	18.18	8.85	4.69	16.69	14.59	6.19	34.41
Intentional injuries	2.79	2.16	3.60	3.21	2.41	4.26	1.71	1.04	2.82
Self-inflicted injuries (suicide)	2.39	1.78	3.20	2.88	2.10	3.95	1.11	0.54	2.25
Violence (homicide)	6.84	3.95	11.83	6.29	3.10	12.75	8.22	4.14	16.36
Ill-defined	5.64	3.76	8.45	6.90	4.42	10.78	2.32	1.23	4.37
Risk factor-related									
Smoking-related	1.08	0.88	1.31	1.07	0.84	1.35	1.10	0.77	1.58
Alcohol-related	8.51	6.57	11.01	9.50	7.12	12.69	5.87	3.59	9.59
Drug-related	1.60	1.02	2.51	1.50	0.88	2.56	1.86	0.85	4.06
Amenable to medical intervention	1.43	1.09	1.87	1.42	1.05	1.92	1.43	0.81	2.54

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Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 2
Age-standardized rate ratios (RR) for potential years of life lost at ages 25 to 74 for Status Indian women living on and off reserve, compared with non-Aboriginal women, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RR	from	to	RR	from	to	RR	from	to
All causes	2.64	2.43	2.86	2.72	2.47	2.99	2.46	2.15	2.81
Communicable, maternal, perinatal and nutritional conditions	4.79	3.35	6.85	3.95	2.81	5.55	6.64	3.47	12.71
Infectious and parasitic diseases	4.01	2.64	6.08	3.28	2.01	5.34	5.54	2.95	10.41
HIV/AIDS	3.42	1.52	7.73	1.30	0.37	4.56	7.92	3.06	20.50
Respiratory infections	8.19	4.43	15.14	6.55	4.00	10.73	11.92	3.69	38.45
Non-communicable diseases	2.12	1.95	2.31	2.15	1.95	2.38	2.05	1.76	2.39
Malignant neoplasms	1.22	1.06	1.40	1.14	0.98	1.32	1.40	1.06	1.85
Stomach cancer	1.58	0.83	2.97	1.40	0.69	2.88	1.87	0.58	5.96
Colon and rectal cancers	1.76	1.20	2.58	1.80	1.15	2.83	1.68	0.84	3.34
Pancreas cancer	0.73	0.40	1.32	0.86	0.44	1.69	0.44	0.13	1.52
Trachea, bronchus and lung cancers	1.00	0.77	1.30	1.10	0.81	1.49	0.76	0.45	1.30
Breast cancer	0.85	0.64	1.13	0.79	0.55	1.13	0.97	0.62	1.53
Cervix uteri cancer	3.93	2.34	6.62	3.32	2.05	5.37	5.37	1.99	14.47
Ovarian cancer	0.95	0.55	1.65	0.88	0.45	1.72	1.12	0.44	2.81
Lymphomas and multiple myeloma	0.71	0.38	1.34	0.69	0.33	1.47	0.75	0.24	2.34
Diabetes mellitus	7.61	5.80	9.99	9.06	6.76	12.14	4.56	2.76	7.53
Neuropsychiatric conditions	3.47	2.48	4.85	2.93	1.89	4.54	4.62	2.88	7.42
Alcohol use disorders	16.75	9.70	28.93	11.43	5.64	23.16	27.96	14.84	52.65
Cardiovascular diseases	2.66	2.27	3.13	2.89	2.38	3.52	2.19	1.71	2.81
Ischemic heart disease	2.22	1.80	2.74	2.34	1.83	3.00	1.99	1.36	2.90
Cerebrovascular disease	3.09	2.35	4.07	3.47	2.51	4.78	2.32	1.45	3.73
Respiratory diseases	3.57	2.20	5.80	4.39	2.52	7.65	1.78	0.97	3.25
Chronic obstructive pulmonary disease	1.52	0.96	2.40	1.53	0.93	2.53	1.42	0.57	3.55
Digestive diseases	7.49	5.80	9.69	7.72	5.63	10.60	6.93	4.82	9.99
Cirrhosis of the liver	9.63	7.08	13.10	8.63	5.83	12.76	11.65	7.53	18.00
Genitourinary diseases	3.71	2.20	6.27	3.18	1.78	5.66	4.72	2.10	10.59
Injuries	4.54	3.70	5.57	5.18	4.07	6.59	3.10	2.31	4.17
Unintentional injuries	5.27	4.09	6.81	5.72	4.22	7.76	4.27	2.99	6.09
Road traffic accidents	3.95	2.78	5.61	4.52	3.01	6.77	2.70	1.56	4.66
Poisonings	14.55	8.68	24.41	16.53	9.01	30.33	10.20	4.91	21.18
Falls	2.46	1.00	6.03	1.68	0.50	5.64	4.11	1.21	13.96
Fires	4.30	1.40	13.21	x	x	x	x	x	x
Drownings	6.52	2.27	18.70	x	x	x	x	x	x
Intentional injuries	3.73	2.58	5.39	4.86	3.26	7.24	1.24	0.65	2.39
Self-inflicted injuries (suicide)	2.79	1.75	4.44	3.71	2.26	6.10	0.76	0.30	1.94
Violence (homicide)	8.61	4.50	16.45	10.80	5.32	21.92	3.75	1.46	9.65
Ill-defined	3.90	2.47	6.15	2.99	1.85	4.85	5.88	2.75	12.58
Risk factor-related									
Smoking-related	1.18	0.88	1.59	1.26	0.86	1.83	1.00	0.67	1.49
Alcohol-related	13.34	9.99	17.80	11.80	8.23	16.92	16.42	11.17	24.13
Drug-related	6.60	4.29	10.16	7.42	4.42	12.46	4.75	2.68	8.39
Amenable to medical intervention	2.04	1.71	2.42	1.92	1.59	2.32	2.30	1.65	3.20

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Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Causes of death

Among Status Indians overall, non-communicable diseases accounted for the highest percentage of total potential years of life lost (PYLL) (53% for men, 69% for women), followed by injuries (38% and 21%) (Appendix Table C). Noteworthy contributors to total PYLL were cardiovascular diseases (19% and 14%), malignant neoplasms (13% and 25%), digestive diseases (6% and 9%), unintentional injuries (26% and 14%) such as road traffic accidents, and intentional injuries (11% and 7%) such as suicide.

The percentage distribution of total PYLL by major cause of death among Status Indians was generally similar whether they resided on or off reserve. However, the percentage of PYLL due to intentional injuries (suicide, homicide) was twice as high for Status Indian women living on than off reserve (8% versus 4%). Malignant neoplasms accounted for a larger share of total PYLL for Status Indian men living off than on reserve (17% versus 12%).

PYLL was also classified as being due to deaths caused by smoking-, alcohol- and drug-related diseases or to diseases that are potentially amenable to medical intervention (for example, cerebrovascular diseases, hypertension, breast cancer, pneumonia/influenza). For Status Indians, the percentages of PYLL attributable to deaths in these categories were: smoking-related (6% for both sexes), alcohol-related (8% for men and 7% for women), drug-related (2% and 5%), and amenable to medical intervention (8% and 20%). The percentages were similar for Status Indians living on and off reserve.

Relative inequalities

The age-standardized rate of PYLL was about two and half times as high for Status Indians as for non-Aboriginal adults, reflecting higher rate ratios for most causes of death (Tables 1 and 2). For all causes combined, the relative inequality was greater among Status Indian men living on than off reserve, but similar for Status Indian women on and off reserve.

Table 3
Age-standardized rate differences (RD) for potential years of life lost at ages 25 to 74 for Status Indian men living on and off reserve, compared with non-Aboriginal men, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RD	from	to	RD	from	to	RD	from	to
All causes	8,692	7,532	9,852	9,976	8,529	11,423	5,293	3,504	7,082
Communicable, maternal, perinatal and nutritional conditions	194	-26	414	226	-53	504	116	-197	428
Infectious and parasitic diseases	-16	-208	176	-16	-260	228	-13	-272	245
HIV/AIDS	-100	-277	78	-93	-322	137	-116	-331	99
Respiratory infections	212	104	321	244	110	378	131	-43	306
Non-communicable diseases	2,669	2,094	3,244	3,003	2,330	3,676	1,757	660	2,854
Malignant neoplasms	-53	-330	224	-107	-406	193	98	-520	715
Stomach cancer	60	-7	128	52	-24	127	83	-61	226
Colon and rectal cancers	60	-93	212	-42	-100	17	321	-205	848
Pancreas cancer	-14	-51	24	-36	-75	2	52	-42	146
Trachea, bronchus and lung cancers	-58	-146	30	-104	-196	-12	69	-139	277
Prostate cancer	5	-20	30	-3	-33	26	32	-19	83
Lymphomas and multiple myeloma	-23	-78	32	-16	-84	52	-39	-124	45
Diabetes mellitus	378	252	503	446	286	605	185	9	361
Neuropsychiatric conditions	500	283	718	586	302	870	277	20	534
Alcohol use disorders	428	271	586	507	305	709	222	12	431
Cardiovascular diseases	878	569	1,188	912	568	1,255	774	116	1,432
Ischemic heart disease	530	333	727	589	359	819	360	-14	735
Cerebrovascular disease	124	-29	277	63	-27	154	282	-216	780
Respiratory diseases	129	40	217	180	60	299	-9	-72	54
Chronic obstructive pulmonary disease	26	-9	60	38	-6	82	-8	-53	37
Digestive diseases	549	347	752	695	423	967	160	-15	334
Cirrhosis of the liver	370	186	555	464	215	713	125	-24	273
Genitourinary diseases	184	33	335	x	x	x	x	x	x
Injuries	4,946	4,053	5,839	5,624	4,505	6,742	3,170	1,818	4,521
Unintentional injuries	3,351	2,677	4,025	3,670	2,847	4,493	2,508	1,372	3,644
Road traffic accidents	1,282	852	1,713	1,472	939	2,005	783	99	1,467
Poisonings	225	91	359	190	45	335	312	13	610
Falls	87	9	165	103	15	191	42	-118	203
Fires	199	36	362	240	21	459	90	-44	225
Drownings	476	234	719	396	148	644	685	96	1,274
Intentional injuries	1,511	931	2,091	1,861	1,108	2,613	601	-114	1,316
Self-inflicted injuries (suicide)	1,069	544	1,595	1,449	762	2,137	82	-524	689
Violence (homicide)	419	178	661	380	80	680	519	139	899
Ill-defined	883	468	1,297	1,124	561	1,687	251	-25	527
Risk factor-related									
Smoking-related	46	-81	173	41	-109	192	62	-174	298
Alcohol-related	967	706	1,228	1,095	763	1,427	627	263	991
Drug-related	102	-16	221	85	-48	218	146	-98	390
Amenable to medical intervention	306	32	580	303	1	605	311	-279	902

x suppressed to meet the confidentiality requirements of the Statistics Act
Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Rate ratios for most communicable and non-communicable diseases were elevated—substantially for some causes. Among Status Indian men, these causes included alcohol use disorders, genitourinary diseases, respiratory infections, diabetes mellitus, and cirrhosis of the liver. Among Status Indian women, rate ratios were particularly high for alcohol use disorders, cirrhosis of the liver, respiratory infections, diabetes mellitus, and infectious and parasitic diseases.

Rate ratios were also high for deaths due to injuries, particularly drowning, violence, fires, road traffic accidents, and poisoning. The magnitude of these relative inequalities was greater among women living on reserve, notably so for suicides (self-inflicted injuries) and violence.

Rate ratios were high for alcohol-related deaths among Status Indians of both sexes, and for drug-related deaths among Status Indian women. However, rate ratios were not statistically elevated for smoking-related deaths, and modestly elevated for deaths amenable to medical intervention.

Absolute inequalities

Among Status Indian men, the overall rate difference, or "excess PYLL," was 8,692 years per 100,000 person-years at risk (9,976 years on reserve; 5,293 years off reserve) (Table 3). Among Status Indian women, excess PYLL was 5,128 years per 100,000 person-years at risk (5,386 years on reserve; 4,561 years off reserve) (Table 4).

More than half (57%) of excess PYLL among Status Indian men was due to injuries, followed by non-communicable diseases (31%) and communicable diseases (2%) (percentages not shown). Percentages were similar for those on and off reserve.

Results differed for Status Indian women, among whom non-communicable diseases contributed the largest share (53%) of excess PYLL, followed by injuries (35%) and communicable diseases (7%) (percentages not shown). The percentage due to injuries for Status Indian women living on reserve was

Table 4
Age-standardized rate differences (RD) for potential years of life lost at ages 25 to 74 for Status Indian women living on and off reserve, compared with non-Aboriginal women, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RD	from	to	RD	from	to	RD	from	to
All causes	5,128	4,487	5,769	5,386	4,582	6,189	4,561	3,535	5,588
Communicable, maternal, perinatal and nutritional conditions	348	206	490	270	160	381	517	133	901
Infectious and parasitic diseases	162	84	240	123	44	201	245	67	422
HIV/AIDS	53	-1	107	7	-28	41	151	2	301
Respiratory infections	178	62	294	138	67	208	271	-69	610
Non-communicable diseases	2,742	2,314	3,169	2,825	2,309	3,341	2,572	1,814	3,331
Malignant neoplasms	341	81	601	219	-41	479	613	11	1,215
Stomach cancer	22	-15	59	15	-23	53	33	-49	115
Colon and rectal cancers	90	12	167	95	0	189	80	-56	215
Pancreas cancer	-14	-37	9	-7	-37	23	-29	-57	0
Trachea, bronchus and lung cancers	0	-78	77	30	-68	128	-70	-189	49
Breast cancer	-66	-169	38	-91	-213	31	-11	-199	177
Cervix uteri cancer	207	72	341	163	60	267	308	-60	675
Ovarian cancer	-4	-50	42	-11	-63	41	10	-80	101
Lymphomas and multiple myeloma	-24	-61	14	-25	-68	19	-20	-90	50
Diabetes mellitus	325	245	406	397	289	504	175	69	282
Neuropsychiatric conditions	223	125	320	174	63	285	327	137	517
Alcohol use disorders	195	115	275	129	45	213	334	161	507
Cardiovascular diseases	764	574	954	870	618	1,122	547	300	794
Ischemic heart disease	246	155	337	270	157	383	199	49	349
Cerebrovascular disease	253	155	350	298	169	428	160	29	291
Respiratory diseases	186	67	306	246	76	416	57	-19	132
Chronic obstructive pulmonary disease	17	-5	40	18	-7	43	14	-29	57
Digestive diseases	621	452	790	643	421	865	568	335	800
Cirrhosis of the liver	380	262	497	336	196	475	468	256	681
Genitourinary diseases	72	30	115	58	16	100	99	5	194
Injuries	1,800	1,364	2,236	2,126	1,530	2,723	1,070	618	1,521
Unintentional injuries	1,147	823	1,470	1,266	832	1,700	876	490	1,263
Road traffic accidents	493	283	703	588	304	872	284	47	522
Poisonings	399	197	600	457	180	733	271	61	480
Falls	17	-8	42	8	-16	32	37	-21	95
Fires	35	-8	79	x	x	x	x	x	x
Drownings	39	-5	82	x	x	x	x	x	x
Intentional injuries	604	316	891	853	445	1,261	54	-124	232
Self-inflicted injuries (suicide)	331	99	563	502	172	833	-45	-177	88
Violence (homicide)	272	103	442	351	111	590	98	-20	217
Ill-defined	238	103	373	164	53	275	402	44	759
Risk factor-related									
Smoking-related	68	-62	199	96	-79	271	-1	-151	149
Alcohol-related	525	390	661	460	299	622	657	412	901
Drug-related	530	276	783	607	258	957	354	106	602
Amenable to medical intervention	800	537	1,064	712	436	988	1,002	417	1,586

x suppressed to meet the confidentiality requirements of the Statistics Act
Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

39%, compared with 23% for those off reserve.

For Status Indian men, road traffic accidents and suicides were large contributors to excess PYLL. Suicide was a larger contributor for those living on reserve, and drowning, a larger contributor for those living off reserve. For Status Indian women, road traffic accidents and poisonings were large contributors to excess PYLL. Intentional injuries such as suicide and homicide were large contributors to excess PYLL for Status Indian women living on, but not off reserve.

The non-communicable diseases that were particularly large contributors to excess PYLL among Status Indian men were cardiovascular diseases, alcohol use disorders, and cirrhosis of the liver. The percentage of excess PYLL due to cardiovascular diseases was greater for Status Indian men off reserve than for those on reserve (percentages not shown). Among Status Indian women, rate differences were elevated for cardiovascular diseases, malignant neoplasms, and cirrhosis of the liver. The percentage of excess PYLL due to malignant neoplasms was higher for those living off reserve than for those on reserve (percentages not shown).

Alcohol-related deaths contributed about 10% of total excess PYLL for Status Indians of both sexes (percentages not shown). The percentages of total excess PYLL attributable to drug-related deaths and to deaths amenable to medical intervention were significantly elevated for Status Indian women.

Socio-economic factors

The magnitude of the difference between Status Indians and non-Aboriginal adults in the risk of dying before age 75 varied by residence on or off reserve and by socio-economic factors (Table 5).

Compared with non-Aboriginal men, the age-adjusted hazard ratios for Status Indian men were 1.92 and 1.58, respectively, for those living on and off reserve (Model 1). Models 2 to 7 each adjusted for age plus a single socio-economic factor. Except for

Table 5
Hazard ratios for death before age 75 among Status Indians living on and off reserve, compared with non-Aboriginal cohort members, controlling for selected demographic, economic, housing and geographic factors, by sex, non-institutional cohort members aged 25 to 74, Canada, 1991 to 2001

Model number and name	Adjusted for:	Men						Women					
		On reserve			Off reserve			On reserve			Off reserve		
		Hazard ratio	95% confidence interval from	to	Hazard ratio	95% confidence interval from	to	Hazard ratio	95% confidence interval from	to	Hazard ratio	95% confidence interval from	to
1 Age	Age	1.92	1.82	2.02	1.58	1.43	1.74	2.37	2.23	2.51	2.27	2.07	2.48
2 Family structure	Age + marital status + single parent	1.73	1.64	1.83	1.40	1.27	1.55	2.30	2.17	2.44	2.12	1.94	2.33
3 Education	Age + education	1.69	1.60	1.78	1.41	1.27	1.55	2.15	2.02	2.28	2.09	1.90	2.28
4 Income	Age + income	1.56	1.48	1.65	1.34	1.21	1.48	2.04	1.92	2.17	1.97	1.79	2.15
5 Work status	Age + labour force	1.65	1.56	1.74	1.41	1.27	1.55	2.12	2.00	2.25	2.11	1.92	2.31
6 Housing	Age + crowding + home ownership + major repairs needed	2.01	1.90	2.12	1.39	1.26	1.53	2.47	2.32	2.63	2.03	1.85	2.22
7 Geography	Age + urban population size	1.86	1.76	1.96	1.54	1.40	1.70	2.33	2.19	2.48	2.23	2.04	2.44
8 Full	Age + family structure + education + income + work status + housing + geography	1.41	1.34	1.49	1.09	0.99	1.21	1.92	1.80	2.05	1.70	1.55	1.87

Source: 1991 to 2001 Canadian census mortality follow-up study.

What is known on this topic?

- The rate of potential years of life lost (PYLL) at ages 1 to 74 is higher for Status Indians than for non-Aboriginal people, with injury deaths the largest contributor to the disparity.
- Premature loss of life is an indicator of the overall health and well-being of a population.
- The effects of socio-economic factors on disparities in premature death are not usually studied.

What does this study add?

- PYLL rates at ages 25 to 74 for Status Indians are typically at least twice those for non-Aboriginal people.
- Both absolute and relative disparities are particularly elevated for injuries.
- Socio-economic indicators such as income, education, housing and employment explain a substantial share of excess premature mortality among Status Indian adults.

Models 6 (for Status Indians on reserve) and 7, which controlled for housing and geographic variables, respectively, the hazard ratios were attenuated, suggesting that each factor had an effect on the disparity. In the full model (Model 8), which controlled for all socio-economic factors simultaneously, the hazard ratios were reduced to 1.41 for Status Indian men on reserve, and to 1.09 for those living off reserve.

Results were similar for Status Indian women: in Model 1, the age-adjusted hazard ratios were 2.37 (on reserve) and 2.27 (off reserve), but in the full model, the hazard ratios were reduced to 1.92 and 1.70, respectively.

Discussion

This study emphasizes the burden of premature deaths among Status Indians of working-age. In other studies of PYLL, the effect of infant and child deaths tended to mask patterns among adults.

The rate of PYLL among Status Indians aged 25 to 74 was approximately two and a half times that of non-Aboriginal adults, and slightly higher for Status Indians living on reserve. Although not directly comparable, the results are consistent with two other studies of PYLL among Status Indians.[6,7]

As was found in other research,[6,25,26] PYLL rates for injury-related deaths were high for Status Indians. In absolute terms, unintentional and intentional injuries were large contributors to excess PYLL among Status Indian men and women.

Even so, the results indicate that chronic diseases are a growing cause of mortality among Status Indians, reflecting an epidemiological transition from infectious to non-communicable diseases.[10] Earlier studies too, have reported that in Aboriginal populations, the prevalence of diabetes is high and continues to increase,[27] and that cardiovascular diseases[28,29] and some cancers[8,30-33] are more common.

Differences between Status Indians residing on and off reserve were not large, although the overall PYLL rate was slightly higher among those on reserve. A Manitoba study found that disparities between Status Indians and other residents were greater in southern than in northern areas of the province.[7] Because the present analysis did not track mobility, the movement of Status Indians between reserves and other locations was not known. Had such information been

available, the geographic differences reported here might have been either reduced or accentuated.

This study demonstrated that socio-economic factors (education, income, housing, and labour force status) were important contributors to disparities in PYLL between Aboriginal and non-Aboriginal people. The results are consistent with other population-based research demonstrating that socio-economic status was an important contributor to health inequalities—specifically, chronic conditions, self-rated health and mortality.[8,34]

Limitations

Several limitations of this analysis must be acknowledged. Eligibility for the cohort was limited to people enumerated by the 1991 census long form. Because of systematic census long-form over-sampling of residents of Indian reserves and remote and northern communities, the cohort had an over-representation of the on-reserve and territorial populations. On the other hand, the 1991 census missed about 3.4% of the population, including residents of 78 Indian reserves (about 38,000 people).

As well, the cohort consists of census respondents who filed taxes in 1990 or 1991. Previous analysis demonstrated that this cohort is longer-lived than the total Canadian population. However, this should have little impact on estimates of relative inequality, because the healthy cohort effect would apply to both Status Indian and non-Aboriginal members. And despite the exclusion of non-tax filers, the socio-economic characteristics of those eligible to be linked and those actually linked to the name file were similar.

The results apply to the non-institutional population on June 4, 1991, not the population as a whole. Status Indians may be over-represented in the institutional population.

Ascertainment of deaths among Aboriginal cohort members is estimated to be slightly lower than for the cohort as a whole. Consequently, a small downward bias in calculated mortality rates for Status Indians is expected, and the true extent of disparities could be somewhat larger than indicated in this study.

Some suicides may have been misclassified as another cause of death such as drowning, poisoning or other injury. The reporting of suicides may also differ by jurisdiction (that is, reserves, towns, cities).

Conclusion

Rates of PYLL were significantly higher for Status Indians compared with non-Aboriginal adults. Non-communicable (chronic) diseases such as cardiovascular diseases and cancers were the largest contributors to total PYLL. However, injuries, especially unintentional injuries, were a major contributor to the disparities, highlighting the importance of injury prevention programs. Many of these health disparities are related to indicators of socio-economic status. ■

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Appendix

Table A
Selected characteristics of Status Indians living on and off reserve compared with non-Aboriginal men and women, non-institutional cohort members aged 25 to 74, Canada, 1991

	Men				Women			
	Status Indian			Non-	Status Indian			Non-
Characteristic	Total	On reserve	Off reserve	Aboriginal	Total	On reserve	Off reserve	Aboriginal
Total number	24,100	17,700	6,400	1,245,100	31,500	21,500	10,000	1,230,600
Percentage	100	100	100	100	100	100	100	100
Age group								
25 to 34	42	42	43	28	45	45	45	30
35 to 44	28	28	29	27	28	27	29	28
45 to 54	16	17	16	19	15	15	15	18
55 to 64	9	9	8	15	8	8	7	13
65 to 74	5	5	4	11	4	4	4	11
Marital status								
Single (never married)	22	22	24	14	16	16	17	11
Common-law	18	17	20	7	17	16	19	6
Married	51	52	48	73	52	55	45	66
Previously married	9	9	9	7	15	13	18	16
Single parent	5	5	4	2	18	17	21	8
Tenure								
Collective dwelling	1	0	3	1	0	0	1	1
Band housing	44	60	1	0	41	59	1	0
Owner	34	29	46	75	32	27	43	72
Renter	22	11	50	24	27	13	55	27
Overcrowding	23	25	16	2	24	30	13	2
Dwelling in need of major repairs	34	39	22	7	33	39	21	7
Educational attainment								
Less than secondary graduation	59	61	53	33	55	58	49	32
Secondary graduation	33	32	35	38	29	27	32	36
Postsecondary diploma	7	6	9	13	13	12	15	19
University degree	2	1	3	16	3	2	4	13
Labour force status								
Employed	51	48	60	76	41	38	48	63
Unemployed	22	23	19	7	11	11	12	6
Not in labour force	27	30	20	17	48	51	41	32
Income adequacy quintile								
1 (lowest)	40	41	35	13	42	43	42	17
2	25	27	22	18	25	26	22	19
3	17	17	18	21	17	17	16	21
4	12	10	15	23	11	10	13	21
5 (highest)	6	5	9	24	5	4	7	21
Region								
Atlantic	5	6	2	8	5	6	2	8
Quebec	9	10	8	26	11	12	7	26
Ontario	18	17	21	37	17	15	22	37
Manitoba	20	23	12	4	17	19	13	4
Saskatchewan	12	12	11	3	13	14	11	3
Alberta	9	9	11	9	12	12	13	9
British Columbia	21	24	15	12	20	22	16	12
Territories	6	0	21	1	6	0	17	1
Community size								
1,000,000 or more	3	1	9	31	4	1	9	33
500,000 to 999,999	4	1	12	16	5	1	14	17
100,000 to 499,999	5	3	10	15	5	3	11	16
10,000 to 99,999	12	10	18	14	12	9	19	14
Less than 10,000	76	85	52	23	73	85	47	21
Living on a reserve								
Yes	73	100	0	0	68	100	0	0
No	27	0	100	100	32	0	100	100

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table B
Age distribution of deaths at ages 25 to 74 among Status Indian and non-Aboriginal men and women, non-institutional cohort members, Canada, 1991 to 2001

	Number		Percentage	
	Status Indian	Non-Aboriginal	Status Indian	Non-Aboriginal
Men	**1,842**	**80,251**	**100.0**	**100.0**
25 to 34	175	1,763	9.5	2.2
35 to 44	309	5,186	16.8	6.5
45 to 54	383	10,161	20.8	12.7
55 to 64	460	20,686	25.0	25.8
65 to 74	515	42,455	28.0	52.9
Women	**1,592**	**40,958**	**100.0**	**100.0**
25 to 34	100	771	6.3	1.9
35 to 44	284	3,223	17.8	7.9
45 to 54	313	6,239	19.7	15.2
55 to 64	443	10,008	27.8	24.4
65 to 74	452	20,717	28.4	50.6

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table C
Cohort members, deaths ascertained, age-standardized rates of potential years of life lost (PYLL) and distribution of PYLL by cause of death at ages 25 to 74 for Status Indians living on and off reserve, compared with non-Aboriginal men and women, non-institutional cohort members, Canada, 1991 to 2001

	Men				Women			
	Status Indians				Status Indians			
	Total	On reserve	Off reserve	Non-Aboriginal	Total	On reserve	Off reserve	Non-Aboriginal
Cohort members	24,100	17,700	6,400	1,245,100	31,500	21,500	10,000	1,230,600
Deaths ascertained	1,842	1,443	399	80,251	1,592	1,122	470	40,958
PYLL rate*	14,676	15,960	11,277	5,984	8,261	8,519	7,695	3,134
	Percentage							
PYLL rate by cause of death	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Communicable, maternal, perinatal and nutritional conditions	4.6	4.4	5.7	4.9	5.5	5.1	6.5	2.4
Infectious and parasitic diseases	2.6	2.2	4.0	4.0	3.0	2.5	4.0	1.3
HIV/AIDS	1.4	1.1	2.3	3.1	0.9	0.4	2.2	0.3
Respiratory infections	2.1	2.2	1.7	0.9	2.3	2.3	2.2	0.9
Non-communicable diseases	52.5	52.4	52.8	76.6	69.4	69.6	68.8	86.3
Malignant neoplasms	13.3	12.3	16.8	34.7	25.0	24.2	26.8	53.8
Stomach cancer	1.0	0.9	1.5	1.4	0.9	0.8	1.0	1.3
Colon and rectal cancers	1.3	1.0	2.6	3.5	2.8	2.8	2.7	4.4
Pancreas cancer	0.6	0.4	1.6	1.8	0.6	0.7	0.3	2.1
Trachea, bronchus, and lung cancers	3.6	3.1	5.7	10.9	4.3	4.7	3.4	11.7
Breast cancer	x	x	x	x	4.9	4.4	6.0	13.8
Cervix uteri cancer	x	x	x	x	3.0	3.0	2.8	1.6
Ovarian cancer	x	x	x	x	1.2	1.1	1.5	3.2
Prostate cancer	0.5	0.4	1.0	1.5	x	x	x	x
Lymphomas and multiple myeloma	1.1	1.1	1.2	2.5	0.8	0.8	0.9	2.7
Diabetes mellitus	4.3	4.6	3.2	2.1	5.6	6.6	3.4	1.8
Neuropsychiatric conditions	4.7	4.8	4.5	2.7	4.2	3.4	6.1	2.8
Alcohol use disorders	3.5	3.7	2.5	0.7	2.8	1.8	5.0	0.4
Cardiovascular diseases	18.8	18.3	20.4	28.0	13.9	17.8	15.2	18.1
Ischemic heart disease	12.6	12.5	12.9	19.1	6.7	7.0	6.1	8.9
Cerebrovascular disease	2.0	1.8	2.7	3.1	5.2	5.6	4.3	4.3
Respiratory diseases	2.0	2.3	1.0	2.5	3.2	3.7	2.0	2.8
Chronic obstructive pulmonary disease	0.8	0.9	0.5	1.7	0.8	0.8	0.7	1.7
Digestive diseases	6.1	6.6	4.1	3.8	9.2	9.0	9.7	3.4
Cirrhosis of the liver	3.6	3.9	2.7	2.2	5.5	4.7	7.3	1.5
Genitourinary diseases	1.5	x	x	0.8	1.5	1.3	1.9	0.8
Injuries	37.8	38.0	37.2	16.2	21.4	22.2	19.6	9.4
Unintentional injuries	25.8	25.9	25.6	8.2	13.9	13.8	14.1	5.0
Road traffic accidents	9.9	10.3	8.3	3.4	6.7	7.1	5.7	2.7
Poisonings	2.5	2.1	3.7	1.0	3.7	3.8	3.4	0.7
Falls	1.2	1.3	0.7	0.7	0.4	0.3	0.7	0.4
Fires	1.4	1.4	1.4	0.3	0.5	x	x	0.2
Drownings	3.0	2.6	4.8	0.4	0.5	x	x	0.2
Intentional injuries	11.1	11.2	10.8	7.5	6.6	8.0	3.7	4.1
Self-inflicted injuries (suicide)	8.3	8.9	6.0	7.0	4.0	5.0	1.8	3.6
Violence (homicide)	2.7	2.1	4.8	0.6	2.6	3.0	1.9	0.5
Ill-defined	5.1	5.2	4.4	2.3	3.7	3.1	5.1	1.8
Risk factor-related								
Smoking-related	6.3	5.9	7.8	15.4	6.0	6.1	5.7	14.9
Alcohol-related	8.2	8.4	7.4	2.5	7.4	6.2	10.2	1.4
Drug-related	2.1	1.9	3.0	1.6	5.1	4.9	5.4	2.1
Deaths amenable to medical intervention	7.7	7.4	8.8	10.0	19.8	19.4	20.9	23.9

* per 100,000 person-years at risk, age-standardized to Aboriginal age distribution (five-year age groups)
x suppressed to meet the confidentiality requirements of the Statistics Act
Source: 1991 to 2001 Canadian census mortality follow-up study.